

Features of cultivation of oilseeds - safflower in contrasting soil and climatic conditions of Russia

Sulukhan Temirbekova*, Yuliya Afanasyeva, Ivan Kulikov, Elena Kalashnikova, Nataliya Ionova

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Abstract

Safflower was introduced into the Central region of the Russian Federation. The results of many years of research have a fundamental and applied significance. Vegetation period from germination to maturity in the years with different meteorological conditions is 94-114 days. The weight of 1000 seeds is 48-51 g. Productivity in contrast zone is 0.7-1.7 t/ha. Safflower seeds contain 30.2-30.9% of fat, the yield of oil is 240 liters kg/ha (in unrefined seeds). From diseases during the wet years of ripening, the safflower culture is affected by enzymatic mycosis seed depletion (EMIS). The enzyme stage of EMIS opens the gate from the seed formation phase to the introduction of the phytopathogens of the genera *Alternaria*, *Fusarium*, *Botrytis*, and *Sclerotinia*. The results of the research showed the suitability of safflower cultivation Krasa Stupinskaya in the Central Region of the Russian Federation for obtaining seeds and oil.

Key words: safflower, oil accumulation, fatty acids, diseases, yield

Introduction

N.I. Vavilov attached special importance to the issue of new cultures, fuller use of the world's wild flora both within our country and abroad. Following his ideas, scientists learn and introduce in the production cultures, previously unknown in our agricultural science and practice. The problem of the introduction of the new crop is becoming increasingly important due to the fact that the

Sulukhan Temirbekova*

All-Russian Research Institute of Phytopathology, Odintsovo, Bolshie Vyazemy, Institute street, 5, 143050, Moscow Region, Russia.

Yuliya Afanasyeva, Ivan Kulikov

All-Russian Selection and Technological Institute of Horticulture and Nursery, 4, Zagor'evskaya Str., Moscow, 115598, Russia.

Elena Kalashnikova

Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, 49, Timiryazevskaya Str., Moscow, 127550, Russia.

Nataliya Ionova

Kazan Federal University, 18, Kremlyovskaya Str., Kazan, 420008, Russia.

*Email: sul20 @ yandex.ru

provision of Russia by vegetable oils and biologically active substances is carried out mainly by imports. Safflower is one of those new cultivations (Gorbatenko 2007).

Adaptive plant breeding aimed to harvest size and quality increasing by their better adaptation to the environment, including the ability to stand the effects of abiotic and biotic stressors. Therefore, global mobilization and adaptation of plant resources is the basis of progress in the more northern areas biologically possible and economically viable cultivation of new crops. Thanks to this were greatly expanded ranges of sunflower, corn, winter wheat, peas, rape, some types of fruit, berry, etc. (Zhuchenko 2011).

The aims of our study were the introduction of safflower in the Central region of Russia, the study of its biological characteristics, the creation of adaptive varieties for use in agricultural production and food processing, and the development of adaptive technology of cultivation recommendations.

Safflower (*Carthamus tinctorius* L.) belongs to the family Asteraceae (Louaer et al., 2018). Its homeland is Egypt and India. As a result of many years of work (2005-2012) in the All-Russian Selection-Technological Institute of Horticulture and Nursery (VSTISP) a new safflower cultivar, Krasa Stupinskaya was created (Authors: Temirbekova S.K., Kulikov I.M., Kurilo A.A., Norov M.S., Metlina G.V., Postnikov D.A., Ionova N.E.). 'Krasa Stupinskaya' is included in the State Register of Selection Achievements in 2013 (Patent № 6930) (Temirbekova 2013). It is recommended for all regions of the Russian Federation (Temirbekova 2014). It is rich in vitamin E (Asmarian et al., 2017; Dubey and Singh, 2019).

At the moment we have reached a clear understanding that human health and life expectancy largely determines the nature of food. The violation of human health is the disturbance of proper nutrition and the extremely low level of human energy consumption. Additionally, it is conditioned by the progress of biochemistry, physiology, and other sciences in the study of biologically active substances' role, including antioxidants, as factors of organism functional activity regulation and as factors that reduce the risk of several diseases (Gins 2011).

Methods

The studies have been conducted in the Center of Gene Pool and Bioresources of plants in All-Russia Horticultural Institute for Breeding, Agrotechnology and Nursery, in 2012-2015 in the All-Russian Research Institute of grain crops (Zernograd, Rostov Region), then we continued work in the Educational-Experimental of Moscow Agricultural of Farm "Mummovskoe" of R.A. Timiryazev Agricultural Academy, in Saratov region, and in Central Tajikistan, Gissar region, experimental production farm of the Tajik Research Institute of Agriculture. The object of research was safflower cultivar *Krasa Stupinskaya* and the collection of samples was done from Tajikistan. Phenological observations and biometric assessments were conducted during the growing season in accordance with the Methodology of State Testing of Agricultural Cultures (1983).

Harvest definition was carried out with using of sample plots in 3 replicates, accounting plot area - 10 m². The determination of oil content in the seeds was conducted in accordance with GOST 10857 «Oilseeds» (1964).

Determination of oil content, and the fatty acid composition of the oil were made in accordance with GOST 30623-98 «Vegetable oils and margarine. Detection method of falsification» (2010). Evaluation of resistance to enzyme-mycosis seed depletion was carried out by the method of Temirbekova S.K. (Temirbekova 2000). Herbicide treatment was carried out according to "Methodological instructions for carrying out production tests of herbicides" (Spiridonov 2004).

The obtained safflower seeds were further used in *in vitro* studies. The work was carried out at the Russian state agrarian University-MSHA named after K. A. Timiryazev, at the Department of genetics, biotechnology, breeding, and seed production.

Results

Agromomic characteristics of safflower 'Krasa Stupinskaya' in contrasting soil and climatic conditions

Comparative study of the growth zone influence on the vegetation period and the main economically valuable signs of safflower grown in four regions was made:

Central Federal District (Moscow region, Mikhnevo), Volga Federal District (Saratov region), the Southern Federal District (Rostov region), and Central Tajikistan (Temirbekova 2016).

'*Krasa Stupinskaya*' is an annual herbaceous plant with a well-

developed tap root system that penetrates into the soil to 10-20 cm, in the southern regions up to 1.5-2 m (and Central Tajikistan) (Norov 2009). The stem is glabrous, erect, branchy, height is about 83-90 cm. Leaves are sessile, lanceolate, oval, or elliptical lancet, on the edges with small teeth, ending with small spines. The inflorescences are many-baskets, 1.5-3.5 cm in diameter. The number of baskets on the plant varies from 5-7 to 20-50. The flowers are tubular, with five separate corolla yellow or orange color. The fruit is an achene, brilliant, reminiscent of sunflower achenes. Its hard shell is difficult to split, and it is 40-50% of the seed weight. The seeds are not crumbled, can germinate at a temperature of 1-2°C, but they germinate better when the soil warms up to 5-6°C and more at a depth of 10 cm.

Sowing in each region annually spent: in Mikhnevo - 7.05-11.05, in the Saratov region - 7.05, in the Rostov region - 26.04, in Central Tajikistan - 20.12 - 25.12 and 10.03 - 15.03 (spring planting). Seedlings always have been friendly and appeared in 3-8 days. The period from the beginning of budding until flowering was within 18-23 days. Flowering lasted about 29-35 days. Harvest ingathering was carried out in Mikhnevo - 23.08, in the Rostov region - 12.08, in the Saratov region - 16.08, in Central Tajikistan 7.04-10.04 (at the winter sowing) and 28 June - 2 July (during the spring sowing). Vegetation period from germination to maturation was 96 days in Moscow region (versus 110-115 days in 2010-2012, 2014-2015), 93-95 days in the Rostov region, and 89-103 days in the Saratov region and in Central Tajikistan - 110 days. In all regions, the safflower vegetation period was almost the same (Table 1).

The calculation of basic safflower harvest indicators gave the following results: the number of plants per 1 m² (p/m²) was in Mikhnevo - 26 p/m², in the Rostov region - 30 p/m² (planted for seeds), in the Saratov region - 62 p/m² (planted for feeding purposes). Plant height ranged from 63-80 cm in all regions. Weight of 1000 seeds and productivity are presented in Table 1. Mass of 1000 seeds were as follows: in Mikhnevo in 2010 - 50.0 g; 2011 - 51.1 g, 2012 - 48.0 g, 2013 - 30.3 g, 2014 - 45.2 g, 2015 - 44.7 g; in the Saratov region in 2013 - 30.9 g, 2014 - 48.1 g, - 43.8 g; in the Rostov region in 2012 - 42.3 g, in 2013 - 53.4 g, 2014 - 42.6 g, 2015 - 46.1 g.

In Moscow region productivity of safflower '*Krasa Stupinskaya*' was in 2013 0.4 t/ha, in 2010-2012 - 0.8 t/ha, 2014-2015 - 0.8 t/ha; in Saratov region: 2013 - 0.9 t/ha, 2014 - 2.0 t/ha and in the 2015 - 0.9 t/ha; in Rostov region - 1.25 t/ha in 2012 and 0.6 t/ha in 2013, 2014 - 1.1 t/ha, 2015 - 0.9 t/ha.

Table 1. Harvest indicators of safflower '*Krasa Stupinskaya*' for 2010-2015 in different regions.

| Years of study | Weigh of 1000 seeds, g | Productivity, t/ha | Vegetative period, days |
|--------------------------------------|------------------------|--------------------|-------------------------|
| Environmental study in Moscow region | | | |
| 2010 | 50.0 | 0.9 | 112 |
| 2011 | 51.1 | 0.8 | 115 |
| 2012 | 48.0 | 0.7 | 115 |
| 2013 (atypical wet year) | 30.3 | 0.4 | 96 |
| 2014 | 45.2 | 0.8 | 113 |

| | | | |
|---|------|------|-----|
| 2015 | 44.7 | 0.8 | 105 |
| Averages | 44.8 | 0.7 | 109 |
| Environmental study in Rostov region | | | |
| 2012 | 42.3 | 1.25 | 93 |
| 2013 | 53.4 | 0.63 | 95 |
| 2014 | 42.6 | 1.1 | 95 |
| 2015 | 46.1 | 0.9 | 94 |
| Averages | 46.1 | 0.9 | 94 |
| Environmental study in Saratov region | | | |
| 2013 | 30.9 | 0.9 | 94 |
| 2014 | 48.1 | 2.0 | 103 |
| 2015 | 43.8 | 0.9 | 89 |
| Averages | 40.9 | 1.2 | 95 |
| Environmental testing in Central Tajikistan | | | |
| 2014 | 34.2 | 1.7 | 109 |
| 2015 | 34.5 | 1.8 | 111 |
| Averages | 34.3 | 1.7 | 110 |

So the average yield of safflower in 2010-2015 was 0.7 t/ha in the Moscow region and 0.9 t/ha in the Rostov region, 1.2 t/ha in Saratov region and in the conditions of the Central Tajikistan 1.7 t/ha with an average weight of 1000 seeds - 34.3 g.

'Krasa Stupinskaya' is recommended as sidereal, phytosanitary, fodder, ornamental, and promising oilseed culture. Best of all as green manure safflower manifests itself on sod-podzolic soils.

Green manure crops (so-called green manure) are an important source of organic matter replenishment in soils. For example, white mustard sown in a hectare of land - is the same that makes it 20 tons of manure for one season, on 1-hectare lupins can save up to 160 kg of nitrogen, which is equivalent to 30-35 tons of manure (Pryanishnikov 1965). Green manure is really conducive to the rapid enrichment of soil organic matter, reduces its acidity and reduces the content of mobile aluminum, and increases microbiological activity. In addition, using green fertilizer, tissue and fruit of plants are not contaminated by chemicals (fertilizers and pesticides).

Traditional green manure crops: white mustard, blue lupine, winter rye, etc. However, there is special culture safflower, which has a number of unique properties for the Moscow region conditions.

Green manure crops have a diversified impact on the nutrient status of soddy-podzolic soil. Plowing under the white mustard post-cut root residues provides involvement optimization of the accumulated nitrogen into the circulation in the topsoil after the decomposition of root residues. Phosphorus accumulation in the root mass of the white mustard is 0.7% but due to the small mass of the roots, their effect on the content of phosphorus in the soil is insignificant. The decomposition rate of the white mustard post-cut root residues decelerates in response to the separation of monocarboxylic acid in plant roots, and, probably, there is no complete decomposition of white mustard root mass at the time of soil samplings (Postnikov 2001; Temirbekova 2015). Potassium content in the soil after the burial of the white mustard post-cut root residues increases as compared with the control by 1%. As a result of the burial of the total white mustard plant mass, soil nitrogen is

back into the soil up to 40 kg/ha. As for phosphorus, its value is to 20 kg/ha. In the context of complete green manuring of blue lupine, soil nitrogen is back into the soil up to 140 kg, allowing keeping a positive balance of this element after harvesting the major crop. The positive dynamics of the content of available phosphorus in the topsoil should be noted (Kurilo 2010).

In a view of plowing the safflower post-cut root residues, nitrogen re-entry in the soil can be up to 8.5 kg, and during the burial of the whole green mass from the root mass to the aboveground part, 120 kg/ha of biological nitrogen returns in the soil in total, that is relatively similar to the blue lupine on average. In terms of P₂O₅, plowing of safflower green mass corresponds to average returns to the soil up to 40 kg/ha. Plowing of safflower at a flowering stage has a positive effect on the exchange of potassium content in the root layer of the soil.

The yields of the dry aboveground part of safflower in different years were as follows: from 9.10 to 9.97 t/ha, and the root part is from 1.30 to 1.60 t/ha. In general, while analyzing the values obtained by the effect and aftereffect of green manuring on the contents of basic food elements in the soil, it is important to emphasize that this technique should be considered in complex with other agrochemical techniques for making compost, fertilizers and meliorates.

The white mustard usage as green manure is of interest to those crop rotations, where the crop is used as between crop and sown in early spring before planting potatoes or autumn after harvesting of the major crop. Under conditions of the southern part of the Moscow region, an effective tool for enhancing the activity of the soil microflora and increasing the isolated circulation of substances in agrocenoses is a burial, which in turn should be used along with the traditional cultures and with introduced plant-culture - safflower (Temirbekova 2015).

We have considered various application schemes of examined green manure crops and revealed that in the case of white mustard full green manuring is optimal in the context of the agronomy, and in case of growing lupine and safflower green material can be used

for feeding purposes. In the absence of livestock specialization, farms should carry out the full burial of aboveground mass of green manure crops, which provide indicators improving effective soil fertility.

In modern agricultural systems, green manuring should not base on the only one culture, because the functional integrity of the intensive agroecosystems is defined by the set of cultivated species, which may belong to different families and thus have diverse effects on agrocoenosis generally. Expanding the green manure crop range creates the right conditions for further domestic agricultural greening, for the integrated and sustainable development of the agricultural sphere as a whole (Kurilo 2010).

Safflower as an oilseed

At the moment, seeds' oil content increasing selection has become a major asset of our agricultural production; such as the property becomes breeding for oil quality change. It has been shown that each variety and even the shape of the population are composed of a larger or smaller number of biotypes differing by the number of features, including the concentration of the fatty acid oil (Ermakov 1972).

The basis in the selection of the quality of oil for technical and food use is the knowledge of genotypic variability of the fatty acids composition in the range of cultivated species and wild relatives. N.I. Vavilov attached great importance to the study of differentiation within the species for chemical signs of quality grades (Vavilov 1967) repeatedly emphasizing the need to identify genetic differences that can be seen in the study in the same conditions of different varieties in different geographical locations.

It was observed that linoleic acid in sunflower oil contains near 67%, and in safflower oil - 80% under the experimental conditions of Kuban station of All-Russian Institute of Plant Industry.

Qualitative differences are determined by genetic characteristics of oil varieties and forms. Oils quality features can be enhanced by content increasing of main fatty acids (oleic and linoleic).

Large variability in the content of linoleic acid in the various years of cultivation, probably due to a stretched period of flowering and late maturing of certain cultures. Fluctuations in temperature cause changes in the partial pressure of oxygen in the cells, which affects the processes of oxidative hydrogenation.

It has been determined the influence of the environment on the unsaturated fatty acids accumulation rate - oleic and linoleic. In all sunflower varieties, intensive accumulation of linoleic acid observed in the more northern growing areas compared with the

southern zone (71.7-72.0 and 53.7-59.0%, respectively). Thus high linoleic acid 46 content combined with a low concentration of oleic (16.9-17.9 and 29.0-36.0%, respectively).

The oils of different crops include fatty acids, mainly with C16 to C22 chains, saturated or unsaturated with double bonds (one, two, three). Within various crop species identified individual grades and within individual varieties biotypes differing by increased or reduced content of typical fatty acids. These biotypes features caused by various factors (mutation, etc.) are also inherited. Individual variability (for plants) is the basis of selection to increasing of concentrations and a decrease in some - other fatty acids, functionally related to each other.

A comparative analysis of the seeds oil content of safflower 'Krasa Stupinskaya' for three years, grown in Moscow and Rostov regions showed that the content of the seeds mass fraction of oil in Rostov region (2013) was 19.02%, which is 4.42% higher than in 2012, in 2014 - 23.7%, which is 9.2% higher than the seeds oil content in 2012. The oil content in the seeds grown in the Moscow region in 2012, showed - 22.92%, which is 8.42% higher than in the Rostov region. In atypical weather conditions in 2013 safflower seeds' oil content grown in the Rostov region was 12.66% higher than that in safflower grown in the Moscow region - 6.4%. In 2014, safflower seed oil content in the Moscow region amounted to 30.2%, which is 6.5% higher than in safflower from the Rostov region (23.7%) (Table 2).

Table 2. The oil content in the seeds of safflower cultivar Krasa Stupinskaya when tested in different regions, 2012-2014.

| Rostov region | | | Moscow region | | |
|---------------|-------|------|---------------|------|------|
| 2012 | 2013 | 2014 | 2012 | 2013 | 2014 |
| 14.50 | 19.02 | 23.7 | 22.92 | 6.4 | 30.2 |

We marked that the accumulation of oil content depends not only on the quantity of precipitation but also by the temperature factor. Moderate rainfall and temperatures above 18°C (phase of flowering and ripening) have a positive effect on the formation of oil content.

It should be noted a direct correlation depending on the proportion of oil mass accumulation in safflower seed culture on the amount of precipitation during the growing season and temperature regime.

It should be noted a direct correlation between the oil content in the seeds of safflower and the amount of precipitation during the growing season and temperature (Temirbekova 2016).

Noted the influence of agro-biological factors on the oil content of seeds safflower cultivation in contrasting years. The analysis of the seed oil content at 5 reproductions 2010-2015 years safflower cultivar Krasa Stupinskaya grown in the Moscow region (Table 3).

Table 3. The influence of agro-biological factors on seed's oil of 'Krasa Stupinskaya' in contrasting conditions, 2010-2014.

| Region, years of study | Oil content (fat mass fraction), % | Precipitation, mm | | Temperature, t 0C | |
|------------------------|------------------------------------|------------------------------|-----------------------------------|------------------------------|-----------------------------------|
| | | Average during Several years | Average during the growing season | Average during Several years | Average during the growing season |
| Moscow, 2010 | 31.2 | 264 | 154.4 | 15.1 | 18.8 |

| | | | | | |
|---------------------------------|------|-----|-------|------|------|
| <i>Moscow, 2011</i> | 29.0 | 264 | 285.5 | 15.1 | 17.8 |
| <i>Moscow, 2012</i> | 22.3 | 264 | 245.8 | 15.1 | 17.8 |
| <i>Moscow, 2013</i> | 6.4 | 264 | 335.8 | 15.1 | 18.4 |
| <i>Moscow, 2014</i> | 30.2 | 264 | 184.1 | 15.1 | 16.4 |
| <i>Moscow, 2015</i> | 30.9 | 264 | 548.3 | 15.1 | 17.6 |
| <i>Central Tajikistan, 2015</i> | 34.3 | 510 | 306.8 | 16.8 | 20.5 |

In 2010, the acutely arid, characterized by high air temperature 18.8°C (longterm average 15.1°C) and low precipitation 154.4 mm during the growing season, the accumulation of a mass fraction of oil in the seeds was 31.2% and in a more humid 2011 - 285.5 mm rainfall during the growing season, temperature 17.8°C in 2012 (optimal warmth, less humid) - 245.8 mm during the growing season, temperature 17.8°C was respectively 29.0 and 22.3%. In 2013, when the rainfall during the growing season fell to 335.8 mm (at a rate of 264 mm) and a temperature of 18.4° C, the mass fraction of fat was only 6.4% in 2014 precipitation during the growing season was 184.1 mm, average temperature - 16.4°C, the oil content was 30.2% in grade 'Krasa Stupinskaya'. In 2015, the oil content of seeds 'Krasa Stupinskaya' was 34.3% in Central Tajikistan and in the Central Region of the Russian Federation - 30.9%. In 2015, the bulk of precipitation fell to the seed of the ripening phase, which allowed obtaining seeds with high oil content.

We conducted a comparative analysis of the oil content determination in the safflower seeds 'Krasa Stupinskaya' for three years, obtained from the Rostov region. Mass fraction of oil in the seeds was 19.02% in 2013, at which is 4.52% higher than in 2012, while the oil content in seeds was 23.7% in 2014 g.

In the Moscow region, the safflower seed oil yield in 2012 was 8.42% higher than in the Rostov region. In 2013 safflower seed oil content in safflower grown in the Moscow region was 12.66% higher than in the Rostov region. In 2014 safflower seed oil grown

in the Moscow region accounted for 30.2%, in 2015 - 30.9 %. The obtained results show the accumulation of oil of the variety Krasa Stupinskaya in the Moscow region, as well as in the homeland of culture - Egypt and India. These results show the dependence of the mass fraction of fat accumulation in the safflower seeds under weather conditions (Tables 3 and 4).

It has been determined the influence of agro-biological factors on seed oil in contrasting years. Analysis of seed's oil content in five safflower reproductions 2010-2015 grown in the Moscow region (Table. 3) shown that in conditions of the 2010 year, characterized by increased air temperature up to 18.8°C long-term (average 15.1°C) and low rainfall up to 154.4 mm during the growing season, the accumulation of oil in seeds was 31.2%. At the same time in 2011 (285.5 mm of rainfall during the growing season, temperature 17.8°C) oil content was 29.0%, and in 2012 (optimal heat - 17.8°C, less humid - 245.8 mm) - 22.3%. In 2013 characterized by high precipitation (near 335.8 mm, t - 18.4°C) oil mass fraction was only 6.4%. In 2014 precipitation during the growing season was 184.1 mm, average temperature - 16.4°C, 'Krasa Stupinskaya' oil content was 30.2%. In Central Tajikistan (2015) oil content was 34.3%. In samples 'Moldir' in 2014 the accumulation of oil in seeds was 24.0%, by the 'Moldir 2008' is 22.2% and 'VIR 2933' up to 21.7%, respectively. It is important for the creation of breeding varieties with different fatty acids ratio in the oil (Table 4).

Table 4. Mass fraction of fatty acids, % to the total content of fatty acids, 2013-2014/

| Fatty acids | 'Mahalli 260' (Tajikistan), 2013 | 'Krasa Stupinskaya', 2013 | 'Krasa Stupinskaya', 2014 | Norms in accordance with GOST 30623-98 [8] |
|-----------------------------|---|----------------------------------|----------------------------------|---|
| <i>C14:0 (myristic)</i> | 0.1 | 0.1 | 0.1 | < 1.0 |
| <i>C16:0 (palmitic)</i> | 7.6 | 7.7 | 9.94 | 2.0-10.0 |
| <i>C16:1 (palmitoleic)</i> | 0.2 | 0.1 | 0.55 | < 0.5 |
| <i>C18:0 (stearic)</i> | 2.6 | 2.0 | 2.48 | 1.0-10.0 |
| <i>C18:1(oleic)</i> | 13.2 | 13.6 | 16.89 | 7.0-42.0 |
| <i>C18:2 (linoleic)</i> | 75.6 | 75.7 | 65.88 | 55.0-81.0 |
| <i>C18:3 (linolenic)</i> | 0.2 | 0.1 | - | < 1.0 |
| <i>C20:0 (arachidic)</i> | 0.3 | 0.4 | - | < 0.5 |
| <i>C20:1 (gondoinovaya)</i> | 0.2 | 0.3 | - | < 0.5 |

According to the content of linoleic acid that is not synthesized in the human body, this 'Krasa Stupinskaya' is not inferior to the southern 'Mahalli 260'. According to the content of oleic acid is 16.89%, responsible for preserving the freshness of the oil over a long period, it exceeded other varieties. The higher content of

saturated fatty acids, particularly palmitic characterized cultivar Krasa Stupinskaya. 'Krasa Stupinskaya, has oil yield near 240 kg/ha (at a plant density of 250-300 thousand/ha and seed yield - 0.8 t/ha). In Central Tajikistan, oil output amounted near 940 kg per hectare (at a plant density of 160 thousand plants per hectare and

crop seeds 1.7 t/ha).

The productivity increase and safflower product quality depend on farming practices of cultivation. It is necessary to adhere to morpho-biological features of crops and varieties, keeping the complex soil-climatic conditions of the region, a specific agricultural production, hydrothermal regime during the growing season. What matters is technical equipment, financial condition, and agronomic management frames.

Therefore, the potential yield and economic effect of the new culture introduction will largely depend on the use cultivation technology adapted to local conditions, taking into account all these factors. All agricultural practices that are recommended for the cultivation of crops should be carried out at one time because the omission or wrong application of one of the elements will affect the yield and quality of seeds.

Protecting plants from pests and diseases

The safflower protection system from pests recommended for seed treatment. It is carried out immediately prior to planting or in advance for 1 -3 months prior to planting preparations Vinczit, KS (25 g/l flutriafol + 25 g/l thiabendazole - 2 l/t) or Maxim, KS (25 g/l fludioksanila 2 l/t) or you can use other modern protectants

authorized for use. Upon reaching on crops of safflower culture economic threshold of harmfulness pests is necessary to apply insecticides: Danadim expert, KE (400 g/l dimethoate) - 0.5-1 l/ ha, Karate Zeon, MKS, 50 g/l of lambda-cyhalothrin - 0.2 -0.3 l/ha, Kinmiks (50 g/l of beta-cypermethrin) - 0.15 l/ha Fufanon Expert BE (440 g/l malathion) - 0.8-1 l/ha, and others.

It should be noted that in wet years sort Krasa Stupinskaya strongly affected enzyme-mycotic exhaustion seeds (EMIS), Figure. 1.

Enzyme stage EMIS, namely, biological injury on the vine in the phase of seeds forming causes cracking of the seed coat, the introduction of plant pathogens and promotes mass seed destruction by *Alternaria*, *Fusarium*, *Botrytis* and *Sclerotinia*, and, eventually, poor quality seeds (Temirbekova 2000, 2008).

Pest safflower can be wireworms and cutworms and other specific pests - Sage scoop and safflower fly.

At the moment, they are absent in the Central region. On safflower, diseases are rust, ramulyarioz (disease manifests itself in the form of spotting on leaves, yellow-brown spots, or brown with dark borders, rounded). Ryamulyarioz occurs singly, not in all the years of cultivation and special harmfulness of the variety does not cause. Rust is not yet available in the Central and North Caucasus regions.

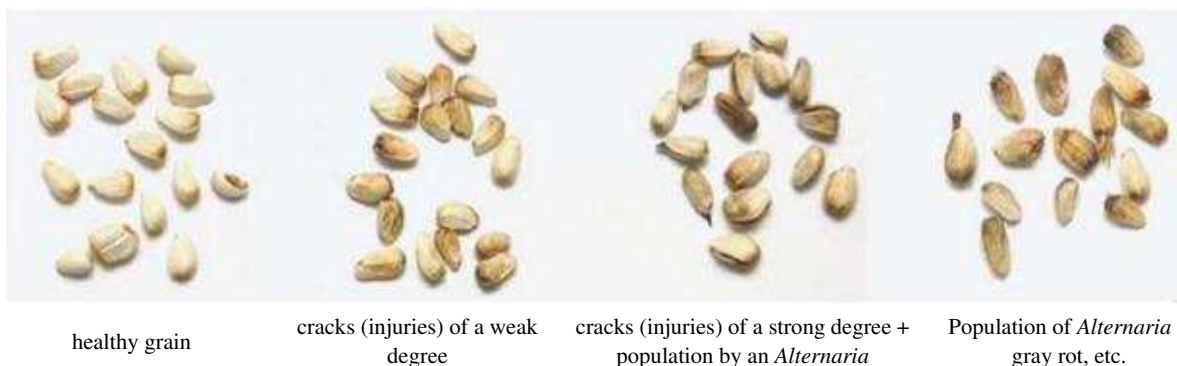


Figure 1. The development of enzyme and mycotic stage of EMIS.

Care of crops

It should take into account the fact that sometimes in the sod-podzolic soil after sowing, soil forms a solid crust that does not germinate seedlings and you'll need 5-7 days to carry out pre-emergence harrowing. When the second pair of true leaves light harrowing is carried out repeatedly. Also, safflower seedlings do not have the ability to control weeds. In this case, processing can be carried out pre-emergence soil herbicides Dual Gold, EC (960 g/l S-metolachlor) new class, the rate is about 1.3-1.6 l/ha (Only permissible minimum dose).

In a production environment, it is not always possible to combine the soil herbicide spraying. In such case only Harmony herbicide spraying rate of 8 g/ha (at the rate of the working fluid flow rate of 200-300 liters of water) in a phase of 8-10 cm monocotyledonous and dicotyledonous weeds must be cared. Therefore abroad use

postemergence herbicides thifensulfuron-methyl, and several others. Active substances). In Russia, several herbicides registered on the above active substance: Aton, WDG (750 g/kg), Harmony, STS (750 g/kg), and others. The recommended rate of application of 6 to 18 g/ha at a flow rate a working liquid 200-300 l/ha. These drugs inhibit dicotyledonous annual, including resistant to 2,4-D and some perennial dicotyledonous weeds.

The active substance, thifensulfuron-methyl, refers to the chemical class of sulfonylureas. The drug is quickly absorbed by the leaves and partially root system of weeds, able to move freely throughout the plant with the descending and ascending nutrients shock. Thanks to the system phloem xylem-effect of the drug penetrates into all parts of the plant and accumulates in the growth points. On the biochemical level herbicide acts on the enzyme acetolactate synthase (ALS), involved in the biosynthesis of amino acids of the chain and disrupts protein synthesis processes, which causes the

cessation of cell division in the meristem tissues.

When clogging annual and perennial cereal weeds recommended postemergence spraying graminicide: Pantera, Fyuzilad Super, Super Zeleke, etc.), they are well combined in tank mixtures with herbicides based on thifensulfuron-methyl. Herbicides Aton and Harmony pretty quickly stop the growth of dicotyledonous weeds which then die before the flowering phase.

It is necessary to produce spatial isolation between safflower and sunflower culture. Seed crops should be removed from the commodity crops at a distance of 0.51.0 km. It requires a thorough cleaning of seeds and their phytopathological examination.

Biotechnology methods are used to create plant forms that are resistant to phytopathogens. We used the method of cell selection. Seeds of safflower varieties 'Krasa Stupinskaya' were investigated *in vitro*. The work on the study of the morphogenetic potential of isolated explants *in vitro* was carried out, cell selection for resistance to *Fusarium L.*

Conclusions

1. The vegetation period from full germination to full maturity safflower culture in the Central Federal District in an excessively wet, atypical in 2013 was 96 days, 2010-2012, 2014 research - 114 and in 2015 - 105 days, average for 5 years - 111 days, in the Southern Federal District - 94 days, in the Volga Federal District - 95 days in Central Tajikistan - 110 days (the average for all years of study).
2. Safflower plant height in all regions ranged from 63.1 to 70.8 cm. Weight of 1000 seeds in different years was 30.3-53.4 g of crop seeds, safflower cultivar Krasa Stupinskaya per 1 ha Moscow region for 2010-2015 amounted to - 0.7 t/ha, in the Rostov region for the 2012-2015 biennium - 0.9 t/ha, in Central Tajikistan - 1.7 t/ha (based on the seed purposes) and in the Saratov region for 2013-2015 years - 1.2 t/ha (based on feed purposes).
3. In all regions, noted a sufficient accumulation of oil content in favorable on agro-meteorological conditions during filling and maturation of seeds. The greatest accumulation of fat mass fraction (in terms of dry matter) in the seeds of safflower dye cultivar Krasa Stupinskaya (Moscow region in reproduction) noted in the harvest 2010, 2011 and 2012 from 22.3 to 31.2% (with the exception of 2013 where the harvest are 6.4%). In the Rostov region, the harvest was from 14.5 to 23.7%, in Central Tajikistan - 34.3%. According to the content of linoleic and oleic acids has not reached the level cultivar Krasa Stupinskaya, which is important for practical purposes.
4. From diseases during the wet years of ripening, the safflower culture is affected by enzymatic mycosis seed depletion (EMIS). The enzyme stage of EMIS opens the gate from the seed formation phase to the introduction of the phytopathogens of the genus *Alternaria*, *Fusarium*, *Botrytis*, *Sclerotinia*. The grown crop has a poor seed quality.
5. In production conditions, the Harmony preparation (6-8 g/ha) was shown to be highly effective against monocotyledonous

and dicotyledonous weeds.

6. The results of the research showed the suitability of safflower cultivation Krasa Stupinskaya in the Central Region of the Russian Federation for obtaining seeds and oil.

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